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Food Insecurity is Associated with Reduced Exclusive Breastfeeding in Western Kenya: Results of a Longitudinal Cohort Study

By

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Master of Public Health

Epidemiology

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Faculty Thesis Advisor

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By

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Western Michigan University
2013

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An abstract of

A thesis submitted to the Faculty of the Rollins School of Public Health of Emory University in partial fulfillment of the requirements for the degree of
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ABSTRACT

Food Insecurity is Associated with Reduced Exclusive Breastfeeding in Western Kenya: Results of a Longitudinal Cohort Study

By
Marlana R. Bates

Background: Household food insecurity (HHFI) is a global public health issue in both developed and developing countries with implications for maternal and infant health. Since it is advised by the World Health Organization that exclusive breastfeeding (EBF) be continued from birth through the first six months of life, infants may be dependent fully on their mother for nutrition during their first 500 days of life, conception to six months of age.
Objective: The objective of this prospective cohort study is to assess the effects of household food insecurity on infant feeding practices, specifically exclusive breastfeeding during the first four months of life
Methods: A secondary analysis was performed on data from 399 mother-child dyads from Western Kenya as part of the Cohort Study on Vitamin A (COVA) evaluating pregnant women from their first trimester to nine months postpartum in four study visits. Exposures of interest were household food insecurity during each study visit, as well as two measures of HHFI chronicity: antenatal food insecurity (ANFI) and antenatal to postpartum food insecurity (ANPFI). Outcomes of interest were breastfeeding within an hour of birth, EBF during the first week of life, EBF from birth to four months, and EBF in a 24-hour recall at four months postpartum. Multivariate logistic regression was used to assess the associations of these exposures with the four outcomes.
Results: Comparing the chronically food insecure households to those that were never food insecure, women had a 45% lower odds of EBF from birth to four months (aOR: 0.55, 95% CI:0.30-0.99), and had a 61% lower odds of EBF in the previous 24 hours (aOR: 0.39, 95% CI: 0.20-0.76). Compared to never food insecure, acutely food insecure women had 55% lower odds of EBF from birth to 4 months (aOR: 0.45, 95% CI 0.22-0.94) and 60% lower odds of EBF in the previous 24 hours (aOR: 0.40, 95% CI 0.18, 0.87).
Conclusions: Household food insecurity is associated with reduced exclusive breastfeeding in Western Kenya and should be considered when devising methods to improve exclusive breastfeeding initiation and maintenance in developing countries.

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INTRODUCTION

Household food insecurity (HHFI) refers to food being inaccessible physically and economically to a household, within the local environment, alongside food being improperly utilized by individuals within the household (1). Globally, it is estimated that 805 million people were chronically undernourished between 2012 and 2014, however this number is 209 million lower compared to previous estimates in 1990 (2), indicating that HHFI is decreasing overall. While Latin America and the Caribbean have made the most progress in increasing food security, progress has only been modest in sub-Saharan Africa and Western Asia (2).

According to *The Lancet* series on Maternal and Child Undernutrition, the three determinant factors of child nutritional status are food security, adequate care, and overall health (3). The first 500 days of an infant's life (from conception to 6 months) are critical for nutrition intervention and promotion of appropriate infant feeding practices, since during this period, an infant may be entirely dependent on their mother for nutrition if exclusive breastfeeding is practiced through 6 months (4). For infant feeding, the World Health Organization (WHO) recommends that exclusive breastfeeding (EBF) occur from birth through six months and that complementary foods be introduced at six months of age, with continued breastfeeding until 2 years of age (5). Household food security (HHFS) as it relates to infant feeding practices, especially exclusive breastfeeding, has not been studied in depth to date. However, the studies that have been conducted in Bangladesh and Brazil evaluating general infant feeding practices, indicate that HHFS is a significant predictor of subsequent breastfeeding practices in both the first and second year of life (6-8). In Brazil, HHFI was associated with a higher prevalence of

breastfeeding in the second year of life (6). In rural Bangladesh, HHFI was associated with mothers not meeting infant feeding recommendations when their babies were between 6 and 12 months of age, but even more food secure households had poor infant diet with minimal dietary diversity and breastfeeding terminated prior to two years of age. While the association between food security status and breastfeeding has been explored in Sub-Saharan Africa, a mixed methods study in Nakuru, Kenya found that the lived experience of food insecurity in Kenyan women reduced their capacity to implement recommended and appropriate infant feeding practices, especially exclusive breastfeeding for 6 months (7-9).

The objective of this prospective cohort study is to assess the effects of household food insecurity on infant feeding practices, specifically exclusive breastfeeding through the first four months of life, using a sample of 399 mother-infant dyads from rural Western Kenya who were followed from pregnancy through 9 months postpartum. The hypothesis of this study is that chronic household food insecurity will have a negative effect on infant feeding practices, decreasing exclusive breastfeeding.

COMPREHENSIVE REVIEW OF THE LITERATURE

Defining household food security (HHFS) and insecurity (HHFI)

The Food and Agriculture Organization of the United Nations (FAO) formed an updated overall definition in 1996 at the World Food Summit stating that "food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (10). The term 'food insecurity' is often used interchangeably with other terms such as nutritional inadequacy or undernourishment, however, household food insecurity refers widely to a triad involving insufficient availability, scarce access, or inappropriate use of food on a domiciliary level. Food security at a household level does not guarantee food security individually, since generally those individuals with control of household income and resources control the food brought into the home (11). Food-insecure individuals can be found in both food-secure and food-insecure homes, similarly, food-secure individuals can be found in both types of households, as well. When a household is food secure, conversely to HHFI, this is referred to as household food security (HHFS).

Recommended infant feeding practices

Infant and young child feeding practices vary based on location, HIV status, maternal health, level of financial resources, and individual circumstance. However, the general guidelines for optimal infant feeding practices to maximize child health are similar worldwide. A combined effort between the World Health Organization (WHO),

The World Bank, and the United Nations Children's Fund (UNICEF) generated the Guide for Essential Practice on Pregnancy, Childbirth, Postpartum and Newborn Care in 2015 (5). This guide provided global guidance on prenatal and antenatal care and infant feeding practices, including early initiative and maintenance of exclusive breastfeeding to 6 months of age and continued breastfeeding with appropriate complementary feeding to at least 2 years. There are many recognized benefits of breastfeeding for infants, including nutrients to meet growth needs, immunological factors to protect against infection, and mortality reduction (12).

Specific recommendations for breastfeeding include the initiation of breastfeeding within one hour of birth when the infant is ready, without any other food or drink introduced. It is also advised that this exclusive breastfeeding (EBF) be continued for the first six months of life since it can benefit infant development, improve mother/baby attachment, and can help delay a new pregnancy, for family planning purposes (5). If breastfeeding is unable to be initiated within an hour of birth, the infant should be examined for any possible health complications. If found to be healthy, the infant can be left with their mother to attempt to breastfeed again within the next three hours. It is advised to help mothers that are ill or unable to breastfeed to express breast milk if possible, feeding the infant with a cup or bottle (5). Commercial infant formula or donated heat-treated breast milk should be used if the mother is unable to breastfeed at all, or if none of these options are possible, home-made formula from modified animal milk should be utilized to feed the infant (5).

Previously, there was some debate over the optimal duration of exclusive breastfeeding (13), but both a 2012 and a 2015 review of the literature indicated that

infants exclusively breastfed for six months experienced greater benefits than those only exclusively breastfed for three or four months or not breastfed at all (14-17). The 2012 Cochrane review included 23 independent studies, with 11 from developing countries (including 2 controlled trials) and 12 from developed countries. The review showed a reduction in gastrointestinal infection for infants and increased weight loss in mothers for those that breastfed exclusively for 6 months, however, there was no indication of long term impact on allergies, growth, obesity, cognitive function, or behavior (16). The more recent review included 13 studies, nine prospective cohort studies, two were secondary analyses from RCTs, and three case-control studies (17). The main finding of the review was that the risk of mortality in predominantly, partially, and non-breastfed infants was higher compared to infants that were exclusively breastfed from 0 to 5 months of age.

For women that are HIV-infected, breastfeeding is still be recommended, with 6 months of exclusive breastfeeding and continued breastfeeding until 12 months (5). HIV-infected women should only stop breastfeeding when a diet that is nutritionally adequate and obtainable is available(5). In mothers without HIV infection, aside from the recommendation to exclusively breastfeed for 6 months, it is also recommended to continue breastfeeding up to at least two years of life, alongside the introduction of complementary foods at 6 months (18).

Infant/maternal health and breastfeeding exclusivity

Multiple patterns of infant feeding exist, including exclusive breastfeeding, predominant breastfeeding, partial breastfeeding, breast-milk substitution, and

complementary feeding (with or without breastfeeding accompanying). Here we describe these various patterns and their implications for infant health. The WHO defines exclusive breastfeeding as infant feeding with no other complementary foods or liquids provided besides breast milk from mother to baby (19). Drops or syrups used for medications, vitamins, or supplements are an exception to the rule and can still be used during exclusive breastfeeding. Predominant breastfeeding means that "the infant's predominant source of nourishment has been breast milk (including milk expressed or from a wet nurse as the predominant source of nourishment)". Partial breastfeeding indicates a style of feeding in which a baby is given some breastfeeds, and some artificial feeds, either milk or cereal or other complementary food (20). Partial breastfeeding can be further broken down to three levels: high, medium, and low. Multiple sources have defined high partial breastfeeding as greater than 80 percent of feeds being breastfeeds, medium as 20 to 80 percent of feeds being breastfeeds, and low as less than 20 percent of feeds being breastfeeds (21, 22) . Breast milk substitutes such as infant formula or modified animal milk are used in place of or to supplement breast milk when needed. When breast milk is no longer adequate to meet the needs of an infant, complementary feeding of solid food and other liquids can be introduced. In many cases, complementary feeding is started well before 6 months of age in infants based on maternal personal choice or circumstance (19).

The health benefits of exclusive breastfeeding for infants have been demonstrated in a variety of studies (15, 23, 24). A longitudinal cohort study analyzing data on 468 women between 8 and 13 weeks of pregnancy from 2001 to 2004 in Krakow, Poland found that the infants breastfed exclusively for 4 to 6 months scored higher by 2.6 points

than those that were fed by mixed feeding practices (including predominant or partial breastfeeding or complete breast-milk substitution) (95% confidence interval (CI): 0.87 – 4.27). The benefit for children breastfed even longer (>6 months) increased by 3.8 points (95% CI: 2.11 – 5.45) in cognitive function assessment tests through preschool age (23). This study supports WHO recommendations on exclusive breastfeeding, and also provides evidence that even a shorter duration of exclusive breastfeeding in early infancy produces beneficial effects on cognitive development in children (23).

Aside from improved cognitive function and overall health, breastfeeding has also been shown to reduce the risk of infectious diseases during infancy. In a prospective cohort study in the Netherlands of prenatally enrolled children born between 2002 and 2006, those who were breastfed exclusively until 4 months of age and partially thereafter had lower risks of infections in the upper and lower respiratory tracts, and gastrointestinal tract until the age of 6 months (adjusted odds ratio (aOR): 0.65 (95% CI: 0.51– 0.83); aOR: 0.50 (95% CI: 0.32– 0.79); and aOR: 0.41 (95% CI: 0.26 – 0.64), respectively) compared with never-breastfed infants (24). The results were adjusted for maternal education, ethnicity, smoking, gestational age, birth weight, siblings, and day care attendance, and were similar for those infants exclusively breastfed 6 months or longer (24).

Another study regarding timely initiation of breastfeeding in Ghana, showed that breastfeeding initiation, both immediately and hours after birth, influenced a child's overall health based on collective health scores (25). Further benefits observed as a result of exclusive breastfeeding in infants include increased linear growth in later infancy in Malawi comparing EBF during the first 6 months of life relative to breastfeeding

supplemented with water or complementary foods during the same time period and improved weight for length in food insecure households in Mexico comparing EBF less than 6 months to greater than or equal to 6 months of age (26, 27).

Maternal benefits of breastfeeding are also widely known and accepted (16). There is more rapid maternal weight loss after birth for mothers that exclusively breastfeed for six months (as opposed to three or four months). A delayed return of menstrual periods is also a benefit of exclusive breastfeeding to improve birth spacing and maternal health and nutrition (16). Breastfeeding can reduce breast cancer and may reduce a woman's risk of diabetes and ovarian cancer (28).

Maternal knowledge and attitudes towards exclusive breastfeeding

Maternal attitudes toward breastfeeding vary throughout different countries and income levels, as well as by awareness and attained education. In a 2013 cross sectional study, completed in a semi-urban community in Nigeria, 383 mothers that breastfed for at least 6 months had a 96% response rate on questionnaires of maternal knowledge, attitudes, and breastfeeding techniques. Of the 383 mothers, 88% had heard of EBF, 71.3% had good knowledge, and 54% had a positive attitude towards breastfeeding (29). In another study, completed in south-east Nigeria with 400 mother-infant pairs in 2012, it was found that awareness of EBF was high (95.3%), as well as knowledge (82.0%), but the actual practice of EBF was fairly low (33.5%) (30).

In an urban area of Central Ethiopia, a cross sectional study from 2014 showed that 68.6% of mothers practiced EBF up to 6 months. Of this group 634 mothers, 97.5%

had a positive attitude towards EBF and 83.4% were knowledgeable of the recommended duration of EBF (31). In Eldoret, Kenya, an urban community, barriers to exclusive breastfeeding were observed in a study with data collected in 2005 (32). Reported barriers included: breast milk unsatisfying to the infant, insufficient milk production, complementary feeding needed to improve nutritional status of the infant, teaching the infant to feed on other foods, and in order for mother's to return to work (32). Factors associated with increased EBF in a cross sectional study in Ghana included planned EBF prior to giving birth, delivery at a hospital, and women living in their own homes (12). Aside from these factors, a positive attitude towards EBF increases the likelihood that mothers will actually breastfeed exclusively. However, education and awareness of EBF and having access to EBF support resources do not necessarily translate to EBF in practice since barriers can be major deciding factors when choosing to breastfeed exclusively.

Despite decreases in the child mortality rate in Africa, neonatal mortality has increased or stayed constant in many countries, with measles, pneumonia, and diarrhea remaining the highest causes (70%) of neonatal death according to UNICEF (30). Due to this fact, education efforts such as the Baby Friendly Hospital Initiative (BFHI) or the Baby Friendly Community Initiative (BFCI) have been implemented in Kenya, Nigeria, and over 150 other countries worldwide, according to WHO (5). The BFHI and BFCI seek to implement practices to protect, promote, and support breastfeeding in a variety of settings and according to WHO and UNICEF breastfeeding recommendations. A cluster randomized controlled trial has been planned to evaluate the feasibility and effectiveness of a community-based intervention that aims to promote optimal breastfeeding and other

infant feeding practices (33, 34). While this study has not yet been completed, it will inform policy and practice in rural Kenya and other similar settings (33). A recent observational study in urban poor settings in Kenya also confirmed that despite general awareness of optimal breastfeeding practices, there was no translation to actual breastfeeding practice (35). This leaves room for improvement based on the one third of children that were breastfed exclusively for six months overall in Kenya, and only 2% in urban settings in 2014.

Household food insecurity and infant health

Relationships have been drawn strongly between HHFS and the health of adults and older children, but there has been far less study of HHFS and infant and young child health (36). HHFI is associated with poor health of adults and children in both developed and developing countries (37). In rural Bangladesh, a cohort study of 1,343 children were followed from birth to 2 years of age, which suggested that HHFS is a determinant of child growth. HHFS was associated with improved weight and length gain ($p<0.05$) and proportions of underweight and stunted growth were significantly lower in food-secure households ($p<0.05$) (37). A cross-sectional study from 2014 in Tehran, Iran, analyzed 423 mother-child pairs with a validated Household Food Insecurity Access Scale (HFIAS) as well as recording duration of breastfeeding and time of introduction of complementary foods (38). This study found no association between HHFI and iron anemia in children 6 to 24 months of age, but did not discount other benefits of breastfeeding and possible iron supplementation programs, when needed (38).

In the United States, food insecurity has been found to be linked with adverse health outcomes among toddlers and infants using data from the Children's Sentinel Nutrition Assessment Project (39). HHFI is of concern to child health since it is associated with inadequate intakes of nutrients, cognitive developmental deficits, behavioral and psychosocial dysfunction, and poor overall health (40). Infants and toddlers who were food-insecure were twice as likely to have 'fair or poor' health as food-secure children (aOR:1.90, 95% CI:1.66-2.18) (39). One study found that food security worked through parental depression and parenting style during infancy causing implications for attachment and mental proficiency in toddlerhood (41). Associations have been found between HHFI and an environment promoting obesity overall in households with children, as well as between HHFI and overweight children under 5 years of age (42, 43). Food insecurity is still a relatively new measure of household and infant/child malnutrition, and the etiology and mechanisms in play are still being uncovered (44).

Household food insecurity and infant feeding practices

The relationship between household food security and general infant feeding practices has been evaluated in a number of countries, including Bangladesh, Brazil, the United States, and Iran (6, 7, 38, 45). In Bangladesh, a longitudinal study observed that better HHFS status was associated with poorer infant feeding practices at 3-6 months of age, but was associated with improved infant feeding practices at 6 to 9 and 9 to 12 months of age (7). HHFS was not associated with the duration of exclusive breastfeeding or any breastfeeding, though it was found that morbidity rates were higher in infants in

food-insecure households than food secure households. Morbidity during infancy was associated with duration of EBF ($p<0.05$). Previously, in Bangladesh, another longitudinal study indicated that household wealth inequality and a household lack of food were associated with childhood adverse growth rate stunting, and that both among children that were never breastfed and children that were breastfed greater than 11 months, the prevalence of growth-stunting is higher (48-56% and 55%, respectively) (46). Mixed messages are sent by these two studies based on length of breastfeeding and HHFS status, however, cultural and regional differences may contribute to the conflicting results.

In Brazil, a longitudinal study of children under 2 years of age found that breastfeeding prevalence was higher in children living in food-insecure compared to food secure households, but only in children over 12 months old (6). No data were collected on exclusive breastfeeding in this study. The study in Iran found statistically significant differences in the mean feeding-practice scores (based on the WHO Infant and Young Child Feeding practice indicators) across food security categories, with feeding scores decreasing as the households became more insecure ($P=0.014$) (38).

Aside from actual infant feeding practices, an observational study in urban Kenya of 148 women (half HIV-affected, half HIV unknown status) observed that food insecurity was associated with poorer attitudes towards exclusive breastfeeding (9). Those women in food-insecure households had higher odds that their breast milk would be insufficient for 6 months (OR:2.6, 95% CI 1.0-6.8) compared to those in food-secure households. In the United States, a study of mothers participating in the Women, Infant, and Children Supplemental Food Program (WIC) found that food insecure mothers were

more likely to participate in restrictive or pressuring feeding styles compared to food-secure mothers, though no associations were found with breastfeeding practices (45). This study evaluated mothers that both breastfed and formula fed their children, but did draw attention to an increased concern for childhood obesity mechanisms and the relationship between food insecurity and obesity in young children. Overall, there is not a large body of literature linking HHFS and infant feeding practices, or even more specifically, HHFS and exclusive breastfeeding.

Household food insecurity and maternal postpartum depression & anxiety

When considering the relationship between HHFI and infant feeding practices, maternal emotional distress, perinatal depression, postpartum depression and anxiety should strongly be taken into account. Maternal anxiety and depression have been found to be associated with food insecurity (47, 48). In rural Ethiopia, an observational study indicated that HHFI may increase the risk of childhood illness, and that mothers with emotional distress have children at the most risk (48). HHFI and increased maternal distress were each independently associated with increased cough and fever in childhood.

In rural Tanzania, similar findings were observed, but more specifically women that were food-insecure after the harvest season had higher levels of anxiety and depression (47). Questionnaire results from this same study pointed to a few possible mechanisms for the connection between HHFI and anxiety/depression. These include the role of HHFI plays in poor dietary intake contributing to anxiety/depression, and also women in the sample may have been using food insecurity as a method of expression of

anxiety/depression. Low-income, pregnant Latina women in the United States that were food insecure were more likely than food secure women to experience elevated levels of prenatal depressive symptoms (49). While this prospective study of 135 women did not report postpartum data, it is important to note depression throughout pregnancy and after-birth to begin understanding the role of HHFI in maternal emotional status.

Another component of maternal distress and food insecurity may be intimate partner violence (IPV), since it has been shown that women that have experienced IPV report greater distress and depression (50). Data from a longitudinal study of low income urban mothers of young children in the United States indicated that mother's experiences of IPV predicted a higher risk of HHFI two years later, which was a relationship mediated by maternal depression (50). While maternal emotional distress affecting young children can take many forms and occur at varying time points ranging from pregnancy onward, food insecurity contributes to this distress, though the mechanisms of this relationship are still being realized.

Maternal Emotional Distress and Exclusive Breastfeeding

Maternal depression has been found to be associated with infant under-nutrition, as well as with early cessation of breastfeeding (51, 52). Postpartum depression has been well established to be related to poor breastfeeding practices among new mothers, but the motivations behind early cessation of breastfeeding are not well understood. A recent observational study in the United States utilizing data from the Infant Feeding Practices Study II showed that women with postpartum depressive symptoms (PDS) had shorter

overall breastfeeding and exclusive breastfeeding duration compared to women without PDS (52). The gap in breastfeeding rates between mothers with PDS and without PDS begins early on during the neonatal period, indicating the possible impact that early diagnosis and treatment of PDS could have on breastfeeding initiation and exclusive breastfeeding.

A study was carried out as part of the control arm of a randomized control trial in Pakistan, which evaluated perinatal depression and breastfeeding practices in 24 depressed and 31 non-depressed exclusively breastfeeding mothers (53). The results of this study found that women with persistent depression ceased EBF earliest, and that depressed mothers were more likely to report inadequate milk production (though actual milk production when measured was adequate). A cohort study in Brazil of infants through two months of age, found that mothers with PDS had an increased risk of early interruption or cessation of EBF in the first and second months of life, but there was not an association between EBF interruption and PDS in mothers that were established in EBF during the first month (54). Other studies have suggested a possible stress-protective role of EBF in PDS in new mothers, however, this has not been confirmed and as a number of other studies have shown, PDS affects breastfeeding practices negatively (55, 56).

Household food insecurity and confounding factors

It is important to consider other factors when examining the association between HHFI and exclusive breastfeeding. Some factors that may be associated with HHFI or

EBF include, wealth, maternal education, BMI, age, and pregnancy weight change as well as infant sex, birth weight, and morbidity (7). Others may include seasons occurring during pregnancy, maternal employment, parity, HIV status, infant feeding practice knowledge, head of household, and gestational age at birth.

Exposure to household food insecurity may differ between rural versus urban environments, so it is important to be aware of the population of interest and to take living situation into account during a study. Socioeconomic status and living in rural vs. urban areas are associated with HHFI in both developed and underdeveloped countries (7, 57-59). Despite poverty, wealth, and education being linked to household food security, directionality and causality of relationships between HHFS and health have not been distinctly defined (60, 61). In urban areas of the U.S., risk of hunger and hunger in low income school age children was associated poor health outcomes, when adjusting for household income (61). While food insecurity is associated with poor health outcomes, most studies do not show a relationship between food insecurity and childhood obesity. In adults, both a modest association and no association have been found between food insecurity and obesity amongst completed studies (60).

With regards to maternal characteristics, one study in western Nigeria showed no correlation between exclusive breastfeeding practices and BMI frequency of breastfeeding (62). Another study, in the US, showed that maternal BMI had limited negative influence on exclusive breastfeeding in the first 4 weeks of life (63). Household food insecurity was associated with higher maternal BMI by single incidence in US based studies, as well as associated with maternal pre-gravid BMI and pregnancy weight gain (64, 65). Infant characteristics have mainly been studied with household food security

according to household characteristics and intervals of age and birth weight (7, 8, 32). Precedence has been set to consider infant sex, age, birth weight, and morbidity when studying the relationship between household food security and infant feeding practices (66).

METHODS

Data for this study were obtained as part of the Mama SASHA COVA community-based longitudinal cohort study in order to evaluate the role that household food insecurity plays in exclusive breastfeeding practices in Kenya. This study was determined to be exempt from IRB approval by the Emory University IRB. The data used were analyzed as secondary data, and included de-identified quantitative data.

Overview

Kenya has the second largest population in East Africa with a young and well-educated workforce, with almost 60% of the population under 25 years of age (67). Kenya has eight major provinces, and for this study the Western Province will be the focus, in Bungoma and Busia Counties. The Sweet potato Action for Security and Health in Africa (SASHA) project was a five year, multi-partner project led by the International Potato Center, which aimed to improve the food security and wellbeing of families in sub-Saharan Africa, especially through an intervention that introduced the orange-fleshed sweet potato (OFSP) for home planting, compared to typical area health care and normally planted crops (68).

The Mama SASHA project was a proof of concept project that tested the effects of integrating delivery of OFSP planting materials with delivery of improved health services and nutrition education on the vitamin A and health status of women and their children. The Cohort Study on Vitamin A (COVA) was a cohort nested in the larger Mama Sasha project that enrolled 505 pregnant women and followed them from their

first antenatal care visit to nine months postpartum. The original goal of COVA was to assess the impact of the Mama SASHA project on maternal and infant vitamin A levels and health statuses, but this is a secondary analysis to examine the influence of food insecurity during and after pregnancy on early initiation of breastfeeding and exclusive breastfeeding practices.

Study Population

The enrollment of the 505 pregnant women for COVA took place between November 2012 and March 2013 at eight participating health facilities, four in the OFSP intervention group and four in the control group. The facilities were approximately 30-50 kilometers apart and were selected for the study by size related variables, including the number of service providers, antenatal care (ANC) visit attendance numbers, population served and the number of surrounding community health workers (68). Women were mobilized to attend ANC by community health workers and once at their ANC visit were referred to COVA by ANC nurses. Women were considered eligible if they were: attending their first ANC visit, 17-40 years of age, estimated 10-24 weeks gestation (determined by date of their last menstrual period or nurse palpation), intending to breastfeed, and intending to reside in the area of the health facility until their child reached 10 months of age (68). If women did not meet these criteria or were involved with Mama SASHA previously, they were not included in the COVA study.

Data collection occurred in conjunction with facility visits at: 10-24 weeks gestation (Visit 1), at approximately four to six weeks before delivery (Visit 2), at four

months postpartum (Visit 3), and at nine months postpartum (Visit 4). For this analysis, mother-infant dyads were excluded if they did not attend the third visit (four months postpartum) since this is when information on the outcomes of interest, initiation and exclusive breastfeeding, were collected (n=105). Dyads were also excluded if they were missing food security data at two of the first three visits (n=1). The final sample retained for this analysis was 399 mother and infant pairs.

Data Collection and Procedures

Data were collected in a standardized questionnaire format, administered by pairs of trained research assistants at each of the health facilities. The questionnaires were administered in English, Kiswahili, or Luyha, depending on preference of the study participant. The questionnaires collected data on household characteristics, household food security and dietary diversity, uptake of health services, prior knowledge about health and nutrition, early infant feeding practices, and both infant and maternal anthropometry. Topics relevant to the analysis included maternal age, parity, attained education, head of household and partner data, maternal employment status, household food insecurity survey, ANC visits, prior infant feeding practice knowledge, maternal weight changes, and infant birth weight.

Household food security was measured using the FANTA Household Food Insecurity Access Scale (HFIAS). This scale has been validated in rural Bangladesh, rural Tanzania, Burundi, and many other developing country contexts (69-72). The HFIAS is intended to measure food insecurity in the 30 days prior to the survey, as long as it is adapted and fit to the local setting of interest (73). The tool has been previously validated and used in Kenya (9). Household assets, productive assets, small animals and livestock

were compiled from the enrollment questionnaire to create a wealth index to use in analysis (74).

Outcome measures

The outcomes for this study included breastfeeding within an hour of birth, EBF during the first week of life, EBF at four months postpartum. All outcomes were coded as dichotomous responses from data collected retrospectively at the third visit (four months postpartum). Exclusive breastfeeding was defined in two ways. In the first method EBF was defined based on recall of any liquids, foods or other non-breastmilk substances in the previous 24 hours. Because this method may overestimate EBF we also queried whether, since birth, the infant had received non-breastmilk substances and if so at what age. These data were used to estimate the variable EBF since birth.

Exposure Variables

HHFI is categorized into four levels: food secure, mildly food secure, moderately food insecure, and severely food insecure. The four level exposure was analyzed at each of the three visits individually, for the applicable outcomes. Since breastfeeding within an hour of birth and EBF in the first week of life are early outcome measures, only data from visit 1 and visit 2 (antenatal measures) were included. HHFI scores at all three visits were used for the two EBF outcomes, EBF from birth to four months and EBF in the past 24 hours (at visit 3), because the antenatal and postpartum periods may both contribute to these outcomes.

Aside from looking at food insecurity at individual visits, the persistence of food insecurity was also considered. The four levels of food insecurity were dichotomized at each visit to the following: any level of food security (including mild, moderate, and severe) and food secure. All three levels of food insecurity were grouped together since over the three visits, those in the mildly food insecure group decreased, primarily shifting into the moderately and severely food insecure groups. Only 2% of the 399 households analyzed maintained mild food insecurity during all three visits. In past literature, moderate and severe food security have been classified together (75-77). However, it has been shown that marginal food insecurity is a predictor for adverse health outcomes in young children, and may have been missed in previous studies since marginal food secure households were often grouped with food secure households (78). Thus we categorized marginal food insecurity with moderate and severe.

After dichotomizing the HHFI levels at each visit, chronicity of food insecurity was then measured across visits. To create the antenatal exposure, considering only the first two visits, if women were food insecure at both visits then, antenatal food insecurity (ANFI) was termed ‘chronic’. If food insecurity was reported at only one visit, then ANFI was termed ‘acute’, and if women were categorized as food secure for both visits, then ANFI was categorized as ‘never’. To create the antenatal to postpartum food insecurity variable (ANPFI) data from all three visits were used; of women reported food insecurity at two or more visits then ANPFI was categorized as ‘chronic’. If women reported food insecurity at only one visit then ANPFI was categorized as ‘acute’. If women were identified as food secure at all three visits, then ANPFI was categorized as ‘never’. These two exposures, ANFI and ANPFI, were used in the main analysis

between HHFI and EBF outcomes. By using two measures of the chronicity of HHFI, the periodicity of breastfeeding outcomes, both early and late, could be successfully investigated.

Covariates

Covariates considered for the analysis were those that have been shown in previous studies to be both associated with HHFI and infant feeding practices, including breastfeeding (7, 57, 59, 61-65). These include the following dichotomous variables: good knowledge of IFP (no/yes), parity (given birth at least 1 time/first pregnancy), partner or husband (no/yes), infant sex (male/female), and intervention group (control/intervention). Continuous variables studied were maternal age, wealth index score, infant birth weight, number of ANC visits, weight gain in pregnancy and weight loss post-pregnancy. Multi-categorical variables that were evaluated were education (no school/any primary/completed primary or more), maternal employment (does not work/non-agricultural/agriculture), and facility location (4 facilities in the intervention group and 4 in the control group). The wealth index was determined from a questionnaire of household and productive assets (74), and was used as a continuous variable since the distribution was normal and had a wide range of values. Head of household, infant morbidity, and maternal HIV status were also considered as possible covariates, but there was insufficient variation within the variables for them to be useful in analysis.

Analyses

Descriptive statistics were estimated for all outcomes, exposure variables, and covariates. Bivariate relationships were evaluated between the covariates and the four selected outcomes, as well as between the covariates and the antenatal to postpartum household food insecurity exposure. The bivariate analysis was completed using Chi-square tests of association with categorical and dichotomous covariates to find the Pearson Chi-square values. Continuous covariates were evaluated in the bivariate analysis with two sample t-tests for the dichotomous breastfeeding outcomes, and with non-parametric tests of association for the ANPFI exposure.

Simple and multivariate logistic regression models were utilized to assess the adjusted and unadjusted associations of HHFI exposure and exclusive breastfeeding. All analyses were conducted in SAS 9.4 statistical software (79). Healthcare facilities and sub-locations (or villages) where study participants lived had to be considered with regards to fixed and random effects in order to avoid the cluster effect. Since the intervention and control groups were randomized by facility, either intervention group or facility needs to be adjusted for, but not both. To determine the best type of base logistic regression model to use, three variations of models were used, including one that was adjusted for the fixed effects of health facility, one accounting for the random effects of sub-location, and another adjusted for both the random effects of sub-location and the fixed effects of health facility. The GLIMMIX procedure was used to complete all modeling and to assess model fit statistics. After testing the three model variations for all four outcomes with both of the main exposures (ANFI, ANPFI), the fixed effects of

facility model had the best fit and the same estimates for measures of association as the random and fixed effect model, with slightly tighter 95% confidence intervals.

Crude unadjusted odds ratios were estimated with the model taking facility into account. Comparisons between categories of food insecurity chronicity were used for each breastfeeding outcome, including chronic vs. acute, chronic vs. never and acute vs. never. When fitting the adjusted models using logistic regression, intervention group was used in the fixed effects base model instead of facility since it yielded a better model fit. Four final models were chosen, one for each breastfeeding outcome, based on covariates found to be significantly associated with the exposures and/or outcomes in bivariate analyses and basic model fit statistics. For the first two models with breastfeeding within an hour of birth and EBF in the first week of life as outcomes, with ANFI as the exposure, both models are adjusted for parity, education, wealth index, ANC visits and intervention group. The third model with EBF from birth to 4 months as an outcome (ANPFI as exposure), was adjusted for employment, parity, education, wealth index, ANC visits, birth weight, and intervention group. The final model for the EBF 24-hour recall outcome (ANPFI as exposure) was adjusted for parity, education, wealth index, ANC visits, and intervention group.

RESULTS

Descriptive analyses

Sociodemographic characteristics of the 399 pregnant women are shown in Table 1 and in Table 2. The average maternal age in the sample was 24.5 +/-5.4 years. About a third (30.3%) of the women had completed less than a primary education and most (88.5%) of the women had a committed partner or were married. The majority of the women had given birth at least once prior to the study (71.9%) but had poor knowledge of infant feeding practices (61.3%). Over a third of the women did not work (37.1%) and on average attended approximately four antenatal care visits during their pregnancies.

Within an hour of birth, 47.9% of infants were breastfed, but the majority (82.8%) of the infants were given breast milk within the first day of life. Of all mother-child dyads, 34.8% reported their child being exclusively breastfed from birth to four months, while 64.4% reported their child exclusively breastfeeding in the 24 hours prior to their 4-month postpartum visit (Table 1). Of the women in the sample, 62.4% of them had experienced food insecurity during at least two of the study visits; only 19.3% were food secure during all three study visits of interest.

Breastfeeding outcomes by food insecurity experiences are presented in Table 3. Breastfeeding practices did not differ across food insecurity categories when examined by study visit. For the ANFI exposure, a statistically significant association ($X^2 p<0.05$) was found with exclusive breastfeeding in the first week of life, and for the ANPFI exposure, a significant association was found with exclusive breastfeeding (24-hour

recall). However, among mothers that were food insecure through the antenatal and postpartum periods, only 33.7% of chronically food insecure and 30.1% reporting acute food insecurity reported exclusively breastfeeding their infant from birth to four months, respectively compared to 42.9% among those who were food secure for the entire period. Using the other EBF outcome (24-hour recall), among mothers that were food insecure through the antenatal and postpartum periods, 61.9% of chronically food insecure and 60.3% reporting acute food insecurity reported exclusively breastfeeding their infant from birth to four months, respectively, compared to 76.6% among those who were food secure for the entire period.

Logistic regression results

Adjusted and unadjusted odds ratios are shown in Table 4. Compared to mothers who have never been exposed to HHFI, mothers exposed to acute HHFI had 44 percent lower unadjusted odds breastfeeding within an hour of birth (95% CI: 0.32-0.97). Significant unadjusted associations were found between acute antenatal food insecurity EBF in the first week of life, as well as between chronic and acute ANPFI and exclusive breastfeeding (24-hour recall). Specifically, compared to those who were acutely food insecure, mothers that were never food insecure had 2.22 times the odds (unadjusted) of exclusively breastfeeding during the first week of life. In other words, acutely food insecure women had 55% lower unadjusted odds than never food insecure women of exclusively breastfeeding during the first week of life (95% CI 0.26-0.79). Comparing the chronically food insecure and the acutely food insecure to never being food insecure, during the antenatal to postpartum period, chronically food insecure women had 52%

lower unadjusted odds of exclusively breastfeeding (24-hour recall) (95% CI 0.26-0.88) and acutely food insecure women had 53% lower unadjusted odds of exclusively breastfeeding (24-hour recall).

Adjusted analyses returned statistically significant ($p<0.05$) associations between ANFI and exclusive breastfeeding in the first week of life, as well as between ANPFI and both EBF outcomes (birth to four months and 24-hour recall). Acutely food insecure women had 56% lower odds than never food insecure women of exclusively breastfeeding during the first week of life (aOR: 0.44, 95% CI: 0.24-0.79). In comparing the chronically food insecure households to those that were never food insecure, women had a 45% lower odds of EBF from birth to four months (aOR: 0.55, 95% CI:0.30-0.99), and had a 61% lower odds of EBF in the previous 24 hours (aOR: 0.39, 95% CI: 0.20-0.76). Compared to never food insecure, acutely food insecure women had 55% lower odds of EBF from birth to 4 months (aOR: 0.45, 95% CI 0.22-0.94) and 60% lower odds of EBF in the previous 24 hours (aOR: 0.40, 95% CI 0.18, 0.87).

DISCUSSION

Based on previous literature review, this study is one of the few in which a relationship between HHFI and infant feeding practices in a developing country has been examined, especially with a focus on exclusive breastfeeding. Many studies in developed countries have investigated the relationship between food insecurity and older child and adult health, but infant and young child health has not been analyzed at length with regards to household food insecurity. We utilized longitudinal food insecurity and infant feeding practice data, with an emphasis on chronicity trends, rather than a change in food security status at each time point individually. Our results show that there is a clear association between HHFI and EBF, demonstrating that those that experience acute or chronic food insecurity have far lower odds of EBF at four months postpartum than those who have stable access to sufficient food during pregnancy and the postpartum period.

The aim of this study was to investigate the effects of HHFI on EBF from birth through the first four months of life. Chronic HHFI exposure in both the antenatal period and the postpartum period were associated with reduced EBF, measured over 4 months and over the previous 24-hour period. These two measurement time points are important to note because the difficulty in measuring infant feeding practices, particularly breastfeeding, has been well documented in the past (80-82).

The two previous studies that were most similar to ours, with regards to household food security and infant feeding practices, both took place in Bangladesh. One found that household food security was a significant predictor of infant feeding practices, but was focused on dietary diversity and dietary adequacy at nine months of age with complementary foods, and did not look at exclusive breastfeeding (8). The other

Bangladeshi study, a longitudinal study that was part of a large intervention trial, found that better household food security was associated with poor infant feeding practices at three to six months of age but was associated with improved infant feeding practices between six months and one year of age (7). This study also found that the duration of EBF did not differ among the household food security levels. Our study findings vary by outcome measurements, since we chose to evaluate breastfeeding on its own, apart from overall infant feeding practices. However, our findings do add to this subject area by observing another association between household food insecurity and non-recommended infant feeding practices, namely early termination of EBF.

The association between HHFI and exclusive breastfeeding could be explained or at the very least be mediated by attitudes towards breastfeeding, as we know that it has been previously shown that food insecurity was associated with poorer attitudes towards EBF in urban Kenyan women (9). Another explanation may include mental health issues, including post-partum depression and maternal anxiety that may be increased with household food insecurity or may contribute to the decision to terminate EBF (47, 83).

Strengths

This study had a variety of strengths as a result of a well planned protocol and detailed implementation. Household food security was measured both during and after pregnancy because this is a longitudinal study, which is not common in this subject area (37). The FANTA Household Food Insecurity Access Scale (HFIAS) is validated and has been used widely across food security literature in both developed and developing

countries. Another benefit of the study was the fairly large sample size for an in depth, time consuming cohort study with pregnant women. The questionnaires at each study visit were quite long, and each visit was most likely tedious for the subjects, as well as a long commitment over 18 months. However, because the women were pregnant and most likely had an interest in their own health and the health of their infants, promoting improved study participation and attendance. Lastly, since this is a cohort study, associations can be drawn about food insecurity and the role it plays in exclusive breastfeeding implementation and maintenance.

Limitations

Despite the many strengths of the study, there were also a number of limitations. Since this is a secondary analysis of previously collected data, there are some desired information that may have contributed to the analysis of the association between HHFI and EBF. Mental health status, including antenatal and post-partum depression would have been beneficial information to collect in order to determine if other factors were decreasing exclusive breastfeeding or if household food insecurity was contributing to mental health status. Data on exclusive breastfeeding were not collected at the nine-month post-partum visit, which could have given the ability to determine if mothers exclusively breastfed their infants to the recommended six months or beyond.

Gestational age was estimated by last menstrual period or if unknown by palpation completed by the nurse. At each visit, the gestational age estimates changed compared to the previous estimates and were very imprecise. Because of this, gestational

age was not utilized in the regression analysis, but should be considered in future similar studies if accurate data is or can be collected. Since this is a very specific environment in Western Kenya, the findings may not be completely generalizable to other settings.

PUBLIC HEALTH IMPLICATIONS

Overall, the few studies that exist evaluating household food insecurity and infant feeding practices have found an association between the two, though the outcomes and time points of interest have varied. Solid evidence has shown the benefits of exclusive breastfeeding to both mother and infant, so it will be a continued point of interest for nutrition interventions in both developed and developing countries. As research in the area of household food insecurity continues in the future, methods for measuring exclusive breastfeeding in practice need to be improved, whether it be through a simple questionnaire or a more in depth scale (80-82). As shown in this study, the 24-hour recall and inquiries about EBF over the previous four months yielded vastly differing results.

For future analysis, a further breakdown of models of food security by each study visit would be beneficial to tease out the relationship between food security and infant feeding practice outcomes at each data collection point during and after pregnancy. It should be considered that infant and young child feeding education and behavioral interventions to improve infant feeding practices will not address rampant food insecurity on their own. Understanding the population of interest would be critical to improving the outcomes of education/behavioral programs in order to account for prevalent household food insecurity that may be detrimental to exclusive breastfeeding success. If household resources to maintain food insecurity are minimal, attitudes towards breastfeeding have negative impacts on participation in exclusive breastfeeding, and post-partum depression or maternal anxiety are present, simple interventions will not reach the heart of the issue.

Future studies between HHFI and EBF should include these mental health measures, and attitudes towards exclusive breastfeeding from mothers and their family members if possible. Pressing into the reasons behind early termination of EBF or alternatively why breastfeeding is avoided completely will allow for effective interventions in the future to encourage and promote EBF. Overall, more research is needed to improve the body of research that reflects the relationship between household food insecurity and exclusive breastfeeding practices.

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TABLES

Table 1: Descriptive analyses of breastfeeding outcomes in 399 mother-infant dyads in Western Kenya through both the antenatal and the postpartum period

Covariates	Overall (n=399)	Breastfed within an hour of birth[a]		p-value	Exclusively breastfed (First Week of Life)		p-value	Exclusively breastfed (From Birth to 4 months)		p-value	Exclusively breastfed (24 hour recall at 4 months postpartum)		p-value
		Yes (n=189, 47.9%)	No (n=206, 52.1%)		Yes (n=223, 55.9%)	No (n=176, 44.1%)		Yes (n=139, 34.8%)	No (n=260, 64.2%)		Yes (n=257, 64.4%)	No (n=142, 35.6%)	
Maternal Age, mean (SD)	24.5 (5.4)	24.5 (5.3)	24.5 (5.6)	0.99	24.8(5.4)	24.1(5.5)	0.21	25.1(5.4)	24.2(5.4)	0.10	24.6(5.4)	24.2(5.5)	0.40
Parity, %													
Given birth ≥ 1 times	71.9	45.6	54.4	0.15	57.5	42.5	0.30	38.3	61.7	0.019	67.9	32.1	0.018
First pregnancy	28.1	53.6	46.4		51.8	48.2		25.9	74.1		55.4	44.6	
Education, %													
No School	1.0	50.0	50.0	0.15	50.0	50.0	0.33	25.0	75.0	0.80	100.0	0.0	0.28
Any Primary	30.3	40.5	59.5		50.4	49.6		33.1	66.9		62.0	38.0	
Completed Primary +	68.7	51.1	48.9		58.4	41.6		35.8	67.7		65.0	35.0	
Good knowledge of IFP, %													
No	61.3	46.3	53.7	0.44	52.7	47.3	0.10	31.8	68.2	0.11	62.5	37.5	0.30
Yes	38.7	50.3	49.7		61.0	39.0		39.6	60.4		67.5	32.5	
Wealth Index Score, mean (SD)	8.6 (1.8)	8.7(1.8)	8.4(1.7)	0.13	8.6(1.8)	8.6(1.8)	0.90	8.5(1.8)	8.6(1.8)	0.65	8.6(1.8)	8.6(1.8)	0.96
Maternal Employment, %													
Does not Work	37.3	45.1	54.9	0.76	50.3	49.7	0.24	24.5	75.5	0.004	58.5	41.5	0.20
Non-agricultural	23.7	47.9	52.1		58.5	41.5		40.4	59.6		68.1	31.9	
Agriculture	39.0	49.3	50.7		59.3	40.7		41.3	58.7		67.1	32.9	
Have partner(s), %													
No	11.5	40.0	60.0	0.26	47.8	52.2	0.24	28.3	71.7	0.32	50.0	50.0	0.03
Yes	88.5	48.9	51.1		56.9	43.1		35.7	64.3		66.3	33.7	
Infant Sex, %													
Male	53.3	47.1	52.9	0.77	56.1	43.9	0.92	34.9	65.1	0.98	62.3	37.7	0.34
Female	46.7	48.7	51.3		55.6	44.4		34.8	65.2		66.8	33.2	
Birth Weight, kg, mean (SD)	3.4 (0.9)	3.4(0.9)	3.4(1.0)	0.84	3.3(0.6)	3.5(1.2)	0.11[b]	3.2(0.5)	3.5(1.1)	0.003[b]	3.3(0.8)	3.5(1.1)	0.19
Intervention Group, %													
Control	51.3	53.2	46.8	0.03	56.9	43.1	0.69	39.7	60.3	0.04	68.6	31.4	0.072
Intervention	48.7	42.2	57.8		54.9	45.1		29.7	70.3		60.0	40.0	
Number of ANC Visits, mean (SD)	3.8(1.3)	3.8(1.2)	3.9(1.3)	0.98	4.0(1.3)	3.7(1.2)	0.01	4.0(1.3)	3.8(1.2)	0.18	3.9(1.2)	3.7(1.3)	0.16
Weight Gain in Pregnancy weekly, kg, mean (SD)	0.3(0.2)	0.3(0.2)	0.3(0.2)	0.11	0.3(0.2)	0.3(0.2)	0.45	0.3(0.2)	0.3(0.2)	0.63	0.3(0.2)	0.3(0.2)	0.52
Weight Loss Post-Pregnancy weekly, kg, mean (SD)	-0.3(0.2)	-0.3(0.2)	-0.3(0.2)	0.71	-0.3(0.2)	-0.3(0.2)	0.60	-0.3(0.2)	-0.3(0.2)	0.31	-0.3(0.2)	-0.3(0.1)	0.29
Facility, % **1[c]**	7.0	50.0	50.0		78.6	21.4		42.9	57.1		64.3	35.7	
2[c]	8.3	33.3	66.7	0.16	63.6	36.4	0.023	33.3	66.7	<0.001	63.6	36.4	0.27
3[c]	16.3	43.5	56.5		44.6	55.4		23.1	76.9		60.0	40.0	
4[c]	17.3	42.0	58.0		50.7	49.3		29.0	71.0		56.5	43.5	
5[d]	13.8	50.9	49.1		47.3	52.7		16.4	83.6		58.2	41.8	
6[d]	22.1	57.5	42.5		61.4	38.6		47.7	52.3		70.5	29.5	
7[d]	5.5	63.6	36.4		45.5	54.5		27.3	72.7		68.2	31.8	
8[d]	9.8	41.0	59.0		66.7	33.3		61.5	38.5		79.5	20.5	

[a] n=4 preferred not to answer [b] non-pooled t-test

[c] Intervention Group [d] Control Group

Table 2: Descriptive analyses of maternal exposure to household food insecurity in 399 mother-infant dyads in Western Kenya through both the antenatal and the postpartum period

Covariates		Overall (n=399)	Food Insecure in the Antenatal to Postpartum Period			p-value
			Chronic (n=249, 62.4%)	Acute (n=73, 18.3%)	Never (n=77, 19.3%)	
Maternal Age, mean (SD)		24.5 (5.4)	24.7(5.6)	24.2(5.2)	24.2(5.1)	0.74
Parity, %	**Given birth ≥ 1 times**	71.9	66.6	18.1	15.3	0.0038
	First pregnancy	28.1	51.8	18.7	29.5	
Education, %	**No School**	1.0	100.0	0.0	0.0	
	Any Primary	30.3	73.6	15.7	10.7	0.008
	Completed Primary +	68.7	56.9	19.7	23.4	
Good knowledge of IFP, %	**No**	61.3	62.9	20.0	17.1	0.28
	Yes	38.7	61.7	15.6	22.7	
Wealth Index Score, mean (SD)		8.6 (1.8)	8.2(1.8)	8.9(1.6)	9.3(1.7)	<0.0001
Maternal Employment, %						
	Does not Work	37.1	61.2	21.1	17.7	0.17
	Non-agricultural	23.7	55.3	23.4	21.3	
	Agriculture	39.1	68.4	12.9	18.7	
Have partner(s), %	**No**	11.5	58.7	21.7	19.6	0.80
	Yes	88.5	62.9	17.8	19.3	
Infant Sex, %	**Male**	53.1	63.7	17.0	19.3	0.76
	Female	46.9	61.0	19.8	19.2	
Birth Weight, kg, mean (SD)		3.4 (0.9)	3.4(1.0)	3.3(1.0)	3.4(0.8)	0.82
Intervention Group, %						
	Control	51.1	58.3	17.7	24.0	0.049
	Intervention	48.9	66.7	19.0	14.3	
Number of ANC Visits, mean (SD)		3.8(1.3)	3.8(1.2)	4.0(1.4)	3.9(1.2)	0.41
Weight Gain in Pregnancy weekly, kg, mean (SD)		0.3(0.2)	0.3(0.2)	0.3(0.2)	0.3(0.2)	0.49
Weight Loss Post-Pregnancy weekly, kg, mean (SD)		-0.3(0.2)	-0.3(0.2)	-0.3(0.2)	-0.3(0.2)	0.43
Facility, %	**1**[a]	7.0	64.3	17.9	17.8	
	2[a]	8.3	57.6	24.2	18.2	0.037
	3[a]	16.3	56.9	23.1	20.0	
	4[a]	17.3	81.2	13.0	5.8	
	5[b]	13.8	45.5	21.8	32.7	
	6[b]	22.1	64.8	13.6	21.6	
	7[b]	5.5	50.0	27.3	22.7	
	8[b]	9.8	66.7	15.4	17.9	

[a] Intervention Group [b] Control Group

Table 3: Descriptive analyses of maternal exposure to household food insecurity by clinic visit/chronicity and breastfeeding practices in 399 mother-infant dyads in Western Kenya.

Food Insecurity	Overall (n=399)	Breastfed within an hour of birth[a]		Exclusively breastfed (1st Week of Life)		Exclusively breastfed (From Birth to 4 months)		Exclusively breastfed (24 hour recall at Visit 3)	
		Yes (n=189, 47.9%)	No (n=206, 52.1%)	Yes (n=223, 55.9%)	No (n=176, 44.1%)	Yes (n=139, 34.8%)	No (n=260, 65.2%)	Yes (n=257, 64.4%)	No (n=142, 35.6%)
Visit 1 (10-24 weeks gestation), n (%)									
Food Secure	126(31.8)	67 (53.2)	59 (46.8)	80(63.5)	46(36.5)	46(36.5)	80(63.5)	89(70.6)	37(29.4)
Mildly Food Insecure	91(23.0)	42(47.2)	47(52.8)	54(59.3)	37(40.7)	36(39.6)	55(60.4)	61(67.0)	30(33.0)
Moderately Food Insecure	84(21.2)	43(51.8)	40(48.2)	41(48.8)	43(51.2)	24(28.6)	60(71.4)	50(59.5)	34(40.5)
Severely Food Insecure	95(24.0)	35(37.2)	59(62.8)	47(49.5)	48(50.5)	32(33.7)	63(66.3)	55(57.9)	40(42.1)
Visit 2 (Final Trimester)[b], n (%)									
Food Secure	139(40.6)	78(56.9)	59(43.1)	82(59.0)	57(41.0)	50(36.0)	89(64.0)	98(70.5)	41(29.5)
Mildly Food Insecure	62(18.1)	31(50.0)	31(50.0)	36(58.1)	26(41.9)	20(32.3)	42(67.7)	35(56.5)	27(43.5)
Moderately Food Insecure	80(23.4)	39(48.8)	41(51.2)	42(52.5)	38(47.5)	28(35.0)	52(65.0)	47(58.8)	33(41.2)
Severely Food Insecure	61(17.8)	24(39.3)	37(60.7)	37(60.7)	24(39.3)	24(39.3)	37(60.7)	42(68.9)	19(31.1)
Visit 3 (4 months postpartum), n (%)									
Food Secure	159(39.9)					62(39.0)	97(61.0)	110(69.2)	49(30.8)
Mildly Food Insecure	61(15.3)					19(31.1)	42(68.9)	38(62.3)	23(37.7)
Moderately Food Insecure	101(25.3)					33(32.7)	68(67.3)	62(61.4)	39(38.6)
Severely Food Insecure	78(19.6)					25(32.0)	53(68.0)	47(60.3)	31(39.7)
Chronicity of Food insecurity during antenatal period (ANFI), n (%)									
Chronic	175(43.9)	82(46.9)	93(53.1)	100(57.1)	75(42.9)				
Acute	123(30.8)	50(42.0)	69(58.0)	57(46.3)	66(53.7)				
Never	101(25.3)	57(56.4)	44(43.6)	66(65.3)	35(34.7)				
		p-value=0.10		p-value=0.02					
Chronicity of Food insecurity from antenatal period through postpartum period (ANPFI), n (%)									
Chronic	249(62.4)					84(33.7)	165(66.3)	154(61.9)	95(38.1)
Acute	73(18.3)					22(30.1)	51(69.9)	44(60.3)	29(39.7)
Never	77(19.3)					33(42.9)	44(57.1)	59(76.6)	18(23.4)
						p-value=0.22		p-value=0.04	

[a] n=4 preferred not to answer [b] n=57 did not attend Visit 2

Table 4. Logistic regression analyses of breastfeeding outcomes by household food insecurity during the antenatal period and at four months postpartum

Antenatal Food Insecurity (ANFI) (%)	Breastfed within an hour of birth				Exclusively breastfed (1st Week of Life)			
	Crude OR	95% CI	Adjusted OR[c]	95% CI	Crude OR	95% CI	Adjusted OR[c]	95% CI
Chronic vs. acute	1.23	0.75, 2.01	1.15	0.70, 1.89	1.36	0.83, 2.22	1.33	0.81, 2.17
Chronic vs. never	0.69	0.41, 1.16	0.84	0.49, 1.44	0.61	0.36, 1.05	0.58	0.33, 1.02
Acute vs. never	0.56[a]	0.32, 0.97	0.73	0.41, 1.30	0.45[b]	0.26, 0.79	0.44[b]	0.24, 0.79
Antenatal to Postpartum Food Insecurity (ANPFI) (%)	**Exclusively breastfed (From Birth to 4 months)**				**Exclusively breastfed (24 hour recall at 4 months)**			
	Crude OR	95% CI	Adjusted OR[d]	95% CI	Crude OR	95% CI	Adjusted OR[c]	95% CI
Chronic vs. acute	1.02	0.56, 1.86	1.22	0.66, 2.24	1.03	0.60, 1.78	0.98	0.55, 1.75
Chronic vs. never	0.57	0.32, 1.02	0.55[a]	0.30, 0.99	0.48[a]	0.26, 0.88	0.39[b]	0.20, 0.76
Acute vs. never	0.56	0.28, 1.15	0.45[a]	0.22, 0.94	0.47[a]	0.23, 0.96	0.40[a]	0.18, 0.87

[a] p-value < 0.05 OR=Odds Ratio CI=Confidence Interval

[b] p-value < 0.01

[c] Adjusted for parity, education, wealth index, ANC visits, intervention group

[d] Adjusted for parity, education, wealth index, ANC visits, intervention group, employment, birth weight